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ABSTRACT

The booklet describes the STAGES (Swine Testing and Genetic Evaluation System) program developed at Purdue University (Indiana), along with the USDA, National Pork Producers Council and swine breed associations. By selecting breeding stock from a coded catalogue developed by STAGES, producers are able to select the best breeding stock for more efficient production. The booklet concludes with a student quiz. (EH)

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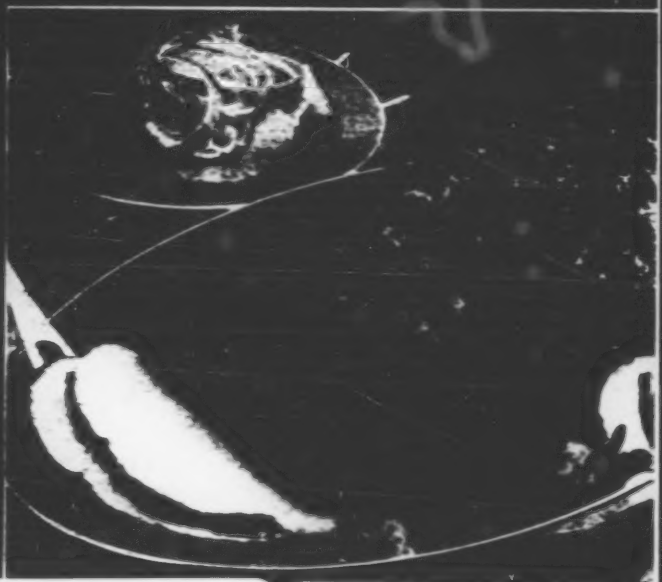

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USING ECONOMICS AND GENETICS TO PRODUCE LEANER PORK

Health experts have determined that proper diet and exercise can lead to longer, healthier lives. Nutritionists say that healthy diets include fruits, vegetables, cereal grains, dairy products, and LEAN meats or legumes. Science and new technology have created many conveniences, and the industrial revolution has also changed the way we work and play. Let's see what a teenager might have done after school in 1900 compared to activities in 1994.

1900	1994
Walk home from school	Take bus or drive home
Carry wood for cook stove/fireplace	Turn up thermostat
Milk cows (by hand) or weed garden	Drive to work (fast food)
Mash potatoes (by hand)	Put frozen french fries in microwave
Play stick ball	Play video game
Carry rugs to clothes line beat to remove dirt	Vacuum carpets
Cut grass with scythe	Cut grass with self-propelled or riding mower

Energy is acquired from the food we eat. A football player is encouraged to eat high levels of carbohydrates and protein before playing a game to develop energy for the muscles he has built through exercise. Foods he may consume are pancakes, sausage, pasta, and meatballs.

However, most of us do not play football, weed gardens, wash clothes on a wash board, cut trees with an ax, or deliver coal, ice, fruits, or vegetables by horse or hand cart to the market place.

Without changing eating and exercising habits, the average American was gaining weight and developing health-related problems. Many have become physically unfit, better known as "couch potatoes." As a result, we have seen exercise equipment and clubs, videos, and diet plans profiled in magazine and television advertising. Food producers also must respond to these changes. On supermarket shelves, we see low-fat, low-sodium, high-fiber food items appearing in response to these demands.

Since high-tech science has been applied to creating an environment that requires the change in our diets, the pork producers have turned to genetic and statistical research to select better pigs which will result in leaner pork products at the supermarkets. How do the meat producers respond to this demand for low-fat products?

Dr. Terry Stewart in the Department of Animal Sciences at Purdue University, along with USDA, National Pork Producers Council, and swine breed associations knew that something had to be done in the industry. In 1983, a new program, Swine Testing and Genetic Evaluation System (STAGES), was developed. During the next ten years, STAGES would move from a curious and complicated computer model to become the hog producers' "consumer's report" of mom and pop pigs for all eight breeds of pigs.

Producers want to grow leaner pigs in the most cost-efficient manner. STAGES enables the producer to make a calculated decision when buying hogs for breeding. Three major factors are important to consider for meeting consumer and grower needs.

1. **Prediction of how many pigs will be born alive to each litter.** This indicates a measure of efficiency of the sow (mother pig). More pigs born live means more pigs sold from the one sow who is managed through pregnancy, birthing, and weaning.

2. **Prediction of weight for piglets at 21 days (weaning age) and at 230 days (average age pigs are sold to a market).** The quicker piglets gain weight and can be successfully weaned and grown out ready to be sold, the lower the management cost (space, heat, feed, labor) per pig, thus the greater profits for the producer.

3. **The amount of backfat—a measure of leanness.** Once the pig is grown, the backfat is the last to develop on the pig. When you see a pork chop in the market with very little or no fat on the edge, this could mean that the meat cutter removed the fat OR the pig was lean with very little fat. Why cut fat off and throw it away? One objective for the pig producer is to avoid growing the backfat which is discarded by the butcher.

How Does STAGES Work?

The Swine Breed Associations collect performance information on sows and their pigs at the same time they get the pedigree (ancestors) information. The performance information recorded is for things like litter size and litter weights of sows and growth rate and lean content of pigs. That information is combined with performance records of all the relatives in the breed association's pedigree file to identify which animals have the best set of genes. The actual process of estimating each animal's genetic value involves an extensive computer program that utilizes quantitative genetic technology. The basic principle is that "like begets like," which was an observation of Robert Bakewell in the 1700s. STAGES just does a better job of describing the parents and the performance of future offspring.

By selecting breeding stock using a coded catalog with the information developed by STAGES, producers are able to select the best breeding stock for more efficient production.

The coding system reflects the evaluation of the expected offspring of the breeding stock for sale, or in the case of males, the semen that can be sold for artificial insemination.

Producers have prided themselves by visually evaluating the quality maternal and paternal lines to breed. However, most will admit this method of selection leaves a lot to guesswork. The STAGES program helps eliminate the guesswork.

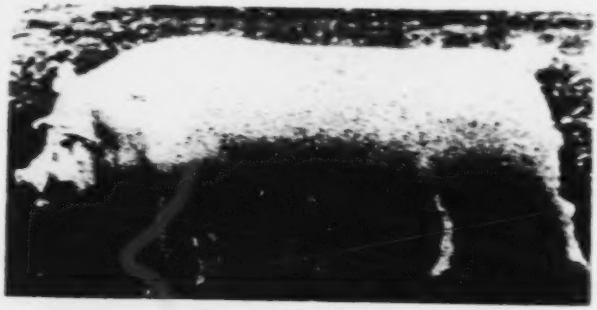
High-quality pigs have the following carcass traits and production characteristics:

- small amount of backfat
- larger muscle area
- greater growth rate (quicker weight gain over a shorter period of time)
- greater feed efficiency (ratio of converting feed to meat)
- larger litter size (more pigs per litter)
- greater pig survival (more pigs per litter surviving)
- greater milk production from sows (to feed pigs)

Should the same characteristics be evaluated for selecting the breeding stock? In general, yes. The STAGES records predict which pigs will be the good parents. The breeder can use this information to decide "which little piggy goes to market and which little piggy stays home" (to produce more high quality pigs).

What determines the value of a boar or sow? Let's look at two boars and calculate which is worth more.

Boar A



Boar B

Boar A: STAGES records show that he	EPD value*
• took 168 days to get to 230 pounds,	(-.7 days)
• at 230 pounds, he had grown .75 inches of backfat, and was	(+.01 inches)
• born in litter of 8 piglets that	(-.2 pigs per litter)
• weighed 121 pounds at 21-days.	(+4.5 lbs. per litter)

Boar B: STAGES records show that he	EPD value*
• took 148 days to get to 230 pounds,	(-5.5 days)
• at 230 pounds, he had developed .65 inches backfat, and was	(-.01 inches)
• born in litter of 12 piglets that	(+.3 pigs per litter)
• weighed 165 pounds at 21-days.	(+8.7 lbs. per litter)

* EPD value—expected progeny difference

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What determines the value of a boar or a sow? Is it their own performance or the performance of their offspring? The value of a boar or sow is the profit the producer derives from the sale of their (progeny) offspring, using this boar or sow as the parent.

The STAGES records of the progeny (offspring) of many parents are coded in terms of Expected Progeny Difference (EPD).

The difference in performance of the progeny of a parent as compared to the progeny of an average parent.

The analysis of the progeny of the breeding stock is measured by using zero as the average animal. Therefore, EPD is used to express the expected progeny difference. In other words, the offspring of this sire (male) would be expected to have pigs that are above or below the average. A minus (-) number would indicate that the measure is less than or quicker.

Sow A — EPDdays -3
Translated, this value means that the pigs born to Sow A will be ready for market three days earlier than pigs from an average sow.

Sow B — EPDdays 4
Translated, this value means that the pigs born to Sow B will take 4 days longer than average to be ready for market.

Average Sow — EPDdays 0
(average genetic value)
This is the average value of all sows.

If all three sows were bred to a boar with the EPDdays of -9, the expected growth of the pigs would be:

Litter from Sow A — -12days (-3 + -9 = -12)
Litter from Sow B — -5days (4 + -9 = -5)
Litter from average Sow — -9days (0 + -9 = -9)

Therefore, a producer can estimate that pigs from Sow A will be ready for market seven days earlier than pigs from Sow B. And, Sow B will likely produce litters ready for market four days later than the average sow." In this case, Sow B is rated less than average.

How much can you pay for a genetically superior boar?

Boar A	Boar B
$450	$900

Which boar is the better buy?

STAGES can help answer this question.

Even though STAGES research has been done for both males and females, to illustrate how much of an economic difference selection can make, we will only illustrate an example for a *terminal sire*. This means that all progeny (offspring) of this sire (male pig used for breeding) will go to market.

A Terminal Sire Example

	Boar A	Boar B
EPD Days	-.7	-5.5
EPD Backfat	+.01	-.01
TSI Index	100	124

In the this comparison (Boar A to Boar B), the offspring of Boar A would be expected to be ready for market about one day earlier than litters from the average sire (-.7). However, Boar B's offspring could be expected to be ready for market about five to six days earlier than the average (-5.5). This means that the earnings would be realized about five days earlier, less feed (a cost), and room in the growing facility for another pig to be grown (reduced overhead).

The expected difference in backfat (less is better), both animals would produce pigs with about the same amount of backfat (Boar B) slightly less backfat (-.01) compared to more backfat in Boar A (+.01).

TSI is an overall score representing the genetic potential and the economic value of the individual traits. If all individual traits of an animal were 0 (average), the TSI would be expressed as 100 (average). The average was set at 100 as a matter of convenience. For Boar A, EPD days are a higher value (-.7), but back fat represents a decreased value (more backfat, +.01). The net result is the average value of 100 for Boar A.

Therefore, the EPD (Expected Progeny Difference) for TSI (Terminal Sire Index) of Boar B indicates a **24 unit** difference in the total genetic values of the pigs marketed from these two boars. Each unit is equal to **$0.10** per pig marketed. Boar B will produce pigs worth **24 units x $0.10 per unit or $2.40 per head more** than the pigs from Boar A.

A pork producer typically breeds a boar for 15 months, raises 6 litters per month from the boar and markets 9 pigs per litter on average. The typical boar should sire about 810 market pigs in his life (15 months, x 6 litters per month x 9 pigs per litter = 810)

Difference in net income	810 pigs x $2.40 =	$1944.00
Difference in cost	$900 - $450 =	$ 450.00
Return over cost		$1494.00
Percent return on investment		332%
Net present value of future return		$1345.00
Discounted return on net present value		299%

Boar B will produce about $1500 more than Boar A. However, the income should be discounted to net present value to accurately represent a truer return for this investment. A discount rate of 5 percent was used in this example.

To understand the concept of discounting, let's say you are a junior in high school. You want to have the money to take a cruise to Alaska after graduation. If the best interest rate you can find for one year is 5 percent,

how much money must you put in a 5 percent annual investment this year to have the $2000 needed for the trip next year? *This is calculating net present value*. Calculate the investment earned on $2000 as 5% of $2000 = 100. So if you invest $2000 today, it will be worth $2100 after one year.

$2000 x .05 = $100

However, we are looking for what we must invest today to have $2000 a year from now. We reverse the calculation by dividing, but we are not looking for 5 percent, we are dividing the amount we are looking for by 105 percent (the whole amount = 100 percent plus the 5 percent interest expected).

$$\frac{\$2000}{1.05} = \$1904.76$$

It would be necessary for you to put $1904.76 in the bank today at a 5 percent annual rate to have $2000 next year. Therefore, the **net present value** of $2000, payable next year is $1904.76 today.

A hog producer must calculate the same thing when deciding to make an investment in his operation. The simple return on investment is figured by dividing the $1494 (total return) by $450 (difference in cost). Indeed, anyone would be happy with a 332 percent return on his/her money; however, this figure must be discounted.

To calculate the discounted net present value, we must realize when the income will be received. The pigs produced from this genetically superior boar will not generate all the return at one time. It will be 12 months before pigs from the first litter are ready for the market. This is the first return on the $450 investment. The last pigs sired by this boar will be sold after 27 months. In other words, the money is not paid in one lump sum as our example of investing for the trip to Alaska. To calculate an accurate discount, the time (12 months to 27 months) must be factored in the formula.

Net present value of income derived from sale of pigs sired by a genetically superior boar.

Month	Pigs sold	Added Value*	Present Value**
1 to 12	0	$0.00	$0.00
13	54	$129.60	$122.94
14	54	$129.60	$122.46
15	54	$129.60	$121.98
16	54	$129.60	$121.50
17	54	$129.60	$121.03
18	54	$129.60	$120.56
19	54	$129.60	$120.09
20	54	$129.60	$119.63
21	54	$129.60	$119.17
22	54	$129.60	$118.72
23	54	$129.60	$118.27
24	54	$129.60	$117.82
25	54	$129.60	$117.37
26	54	$129.60	$116.93
27	54	$129.60	$116.49
Total	810	$1944.00	$1794.96
Net return		$1494.00	$1344.96
Percent return		332	299

* $2.40 per pig X 54 pigs per month

** PV=Value/(1+interest rate per month x number of months), assumes simple interest

If we use the same example as we did for the trip to Alaska, how much do I need to invest today to get a return of $1494 in 13 to 27 months ($129.60 per month) invested at a rate of 5 percent compounded monthly, the answer would be $1344.29. Taking these variables into consideration, the return is discounted from a 332 percent return to a 299 percent return on investment to account for the time delay, still an impressive return.

The American Yorkshire Club, along with the other pure bred associations, bought into this system and is convinced that STAGES helped make quality improvements for their industry. They estimate that the combined value of genetic improvement is $10 for every litter produced by using either Yorkshire sires (males) and/or dams (females). This value

was estimated by determining that each year the STAGES system was used to select breeding stock, that on average every year, litters increased in value by $1. As shown in Figure 1, over a period of ten years, the value of litters from Yorkshire hogs has increase by $10 per litter from 1983 to 1993.

Dr. Harmon, head of the Animal Sciences Department at Purdue University, states, "A $10 improvement may not seem like much, but multiplied by the estimated number of gilts (female pigs who have never born piglets) per year produced by boars and sows with STAGES evaluation, the improvement amounts to $7.6 million dollars in the last eight years." This translates to a win, win situation. Producers are raising better market pigs and consumers are getting leaner pork without paying more at the market.

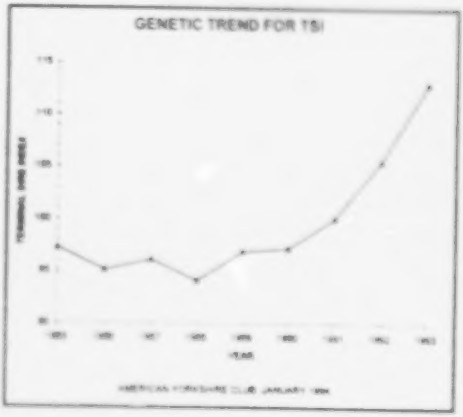

Figure 1

SUMMARY

To meet consumer demands for leaner meats that do not increase the American consumer's food dollar, a careful study of swine genetics and efficiency of production factors have helped producers select breeding stock to provide leaner meat without increasing production cost. This is an important factor to maintain an acceptable food budget for consumers.

Five to eight years of planned breeding are required to obtain the quality of meat breeders are striving for to meet consumer demand. Breeding decisions to determine quality of pork products in the year 2000 are being made today, and the STAGES program is helping producers make these decisions.

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Terry Stewart

Terry S. Stewart is a Professor of Animal Genetics in the Animal Sciences Department at Purdue University. Stewart received his B.S. and M.S. degrees in Animal Sciences from the University of Florida in 1972 and 1974. He received his Ph.D. in Animal Breeding and Genetics from Texas A&M in 1977. He joined the Purdue staff in 1977 with research and teaching responsibilities in Animal Breeding, Genetics and Livestock Systems Management.

Professor Stewart teaches undergraduate classes in Animal Breeding and counsels undergraduate students. He is the leader of research in charge of the STAGES (Swine Testing and Genetic Evaluation System) program which provides the technical support for genetic evaluation of the U.S. purebred swine industry. He also conducts research on selection and mating systems to improve maternal production in swine. In addition, he collaborates with the swine lean growth research group and the beef cattle genetics group.

The technical and professional assistance provided by Professor Stewart for this publication is greatly appreciated.

QUIZ:

Multiple Choice—Circle the letter of the most appropriate answer for each of the following.

1. Lean meat is important in changing diets of Americans because
   A. it replaces calories obtained from eating carbohydrates.
   B. eating less fat in meat products helps reduce calories in the diet while providing protein, vitamins, and minerals
   C. it reduces the risk for high blood pressure and heart disease.
   D. B and C are true.
   E. all of the above are true.

2. The STAGES methods of selecting breeding stock to grow pigs was developed
   A. by using genetic and statistical research to select better breeding stock in the swine industry.
   B. to produce more pigs that grow quicker and have less backfat.
   C. by using a panel of highly experienced animal experts for selection because "like begets like" in genetic traits.
   D. A and B are both true.

3. Which of the characteristics listed in the text would you think are important for sow (female) characteristics?
   A. greater number of pigs per litter produced.
   B. slim bellies (generally will produce larger litters).
   C. round rump (able to carry more pigs through pregnancy).
   D. long rib (producing more pork chops).
   E. all of the above are true.

4. The superior quality of Boar B pictured has higher value than Boar A due to which of the following characteristics?
   A. fewer days to grow to 230 pounds.
   B. heavier litter weight at weaning (21 days).
   C. born to a mother producing a larger litter.
   D. all of the above are true.

5. In comparing Boar A to Boar B on page 7 of the text, offspring from Boar B would

A. grow faster
B. be leaner
C. have larger litters at birth
D. have heavier litters at weaning
E. All of the above are true.

6. If a sow with an EPDdays of -2 was bred to a boar with the EPD days value of -7, how many days from the average would a producer expect the pigs to be ready for market?

A. 5 days sooner than the average litter.
B. 9 days sooner than the average litter.
C. 5 days later than the average litter.
D. 9 days later than the average litter.
E. not enough information to estimate.

7. Why is it not appropriate to calculate a discount rate for purchasing a breeding animal using the same formula you use for investing to buy a new stereo?

A. the price of pigs at the market varies daily.
B. the interest rate for the investment to buy a stereo may change over the year that your money is invested.
C. the income from the investment in a genetically superior breeding animal will not be received in a lump sum.
D. B and C are true.

8. Using the average difference in net income in our text, if a pig producer spends $560 more than average on a genetically superior boar than he would on an average boar, what would be the percent return on his investment considering discounting?

A. 267 percent
B. 347 percent
C. 240 percent
D. 125 percent

9. Mark has saved $600 to begin a business using STAGES breeding stock. How much extra money will he need to earn working at the gas station to have enough money to invest this year at 6 percent to buy a boar next year costing $790?

A. $496
B. $145
C. $34
D. $432

10. In the text, why is the Terminal Sire Index (TSI) of Boar A 100?

A. Boar A is a typical boar of average value.
B. Boar A is 100 times better than any boar ever used in the Yorkshire breed.
C. Boar A will produce an average of 24 fewer pigs in his lifetime than pigs produced from Boar B.
D. Boar A will produce an average of 100 pigs in his breeding lifetime.

ANSWERS: 1-D; 2-D; 3-A; 4-D; 5-E; 6-B; 7-C; 8-C; 9-B; 10-A

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